With the Author's compliments

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AN INVESTIGATION

OF AN

OUTBREAK OF COW-POX IN WILTSHIRE

WITH A COMPARATIVE ACCOUNT OF SOME PREVIOUS OUTBREAKS IN ENGLAND, GERMANY, AND FRANCE.

BY

PROFESSOR EDGAR CROOKSHANK, M.B.,

OF KING'S COLLEGE, LONDON.

[Reprinted for the Author from the BRITISH MEDICAL JOURNAL, July 7 and 14, 1888.]

PRINTED AT THE OFFICE OF

THE BRITISH MEDICAL ASSOCIATION, 429, STRAND, W.C.

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Fig 2

Fig 3

Fig 4

Fig 5

Fig 6

Fig 1.

PLATE II.

TO ILLUSTRATE
THE PAPER BY PROFESSOR CROOKSHANK ON COW POX.

Vincent Brooks, Day & Son, Lith.

PLATE 1.
TO ILLUSTRATE
THE PAPER BY PROFESSOR CROOKSHANK ON COW POX.

AN INVESTIGATION

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OUTBREAK OF COW-POX IN WILTSHIRE.

In the course of an investigation undertaken on behalf of the Agricultural Department of the Privy Council into the micro-pathology of a disease in cows in Wiltshire, and its relation, if any, to scarlet fever in man, I was led, on observing several cases of transmission of this cow-disease to the hands of the milkers, to pursue another line of inquiry—the nature and origin of the disease in question.

In the abstracts of my reports which have been published, I have given a few details of the clinical characters of the disease in the cow and in man. I will now fulfil my intention of giving a complete account of the disease as I observed it by repeated visits to the farms. I will also describe in detail the cases of the milkers and the evidence which has confirmed the statements of experienced persons that the disease was cow-pox, a disease which has existed in Wiltshire from time immemorial. I will give, for purposes of comparison, a short account of some previous outbreaks, described in the writings of Jenner, Ceely, Hering, and others. Having recently conferred with some of the leading veterinary surgeons and authorities on vaccination in France, I have succeeded in obtaining the history of some of the more recent outbreaks of cow-pox in that country, including the Bordeaux cow-pox, which was the source of the lymph supplied to the Medical Department of the Local Government Board, and so largely used in this country. The history of these recent outbreaks throws great light on the characters of the natural disease in the cow, and will serve for future guidance in the detection of the disease and in the mode of raising, if necessary, fresh stocks of lymph.

Locality of the Wiltshire Outbreak.—There is considerable interest attached to the fact that the farms I inspected are situated a few miles from Cricklade. They are close to the borders of Gloucestershire, and about twenty-five miles from Berkeley. They are, therefore, within that district which was easily within Jenner's reach, a district which he described in his day as one in which the cow-pox was particularly prevalent.

Another matter of considerable interest is the statement that the very first case of casual cow-pox which was put to the variolous test came from this neighbourhood, and quite possibly from one of the very farms on which the recent outbreak has occurred, these particular dairy farms having been in existence for several generations.

Dr. Lettsom, in his *Observations on the Cow-pock*, published in 1801, writes as follows: "The Cow-pock.—This eruptive disease of the nipples of the cow which I attempt to elucidate has long existed in various parts of the counties of Gloucester, *Wilts*, Somerset, Buckingham, Devon, Hants, Suffolk, Norfolk, Leicester, Stafford, and the vicinity of London." And then, after eulogising "the name and discovery of Dr. Edward Jenner," he qualifies his praises by the following footnote: "Although the cow-pock has long since been found by incidental experience a security against the small-pox, it had never been applied to any beneficial purpose till the genius of Jenner discriminated its powers and introduced it into practice as a permanent security against the variolous infection. This preventive quality of the vaccine fluid was certainly known, even to scientific professional men many years ago; but, strange as it may now appear, no one, till Jenner promulgated his discovery, had ever improved that knowledge by applying it to the process of inoculation. About twenty years ago, when Dr. Archer was the physician of the hospital for inoculation, Catherine Wilkins, now Titchenor, *from Cricklade in Wiltshire*, who had had the cow-pock in consequence of milking cows, came to her brother in London (where she is now resident), who, being desirous of ascertaining whether this circumstance could be depended upon as preventive of the small-pox, sent her to the hospital for inoculation, when she received the variolous matter from Dr. Archer, against which, however, she was proof, and the small-pox, of course, could not be communicated; but no advantage was derived from the fact."

Time of Year.—The outbreak last year commenced about the end of September, and lasted until about the middle of December. In an outbreak in 1885, a few miles from these farms, but on a separate estate, the disease appeared in June and July.

Climatic and other Conditions.—It has often been previously observed that outbreaks of small-pox and cow-pox have been coincident; it is, therefore, interesting to bear in mind that the outbreak in Wiltshire was, to a certain extent, coincident with a wave of small-pox which passed over this country, and that these outbreaks succeeded an exceptionally dry summer.

Origin of the Outbreak.—I made close inquiries as to the origin of the outbreak, but beyond ascertaining with certainty that the disease appeared first at one farm, and was conveyed from this to the other farms, all evidence was negative. The milkers were unable to say whether it commenced in one particular cow or whether it broke out in several simultaneously.

There were no horses on this farm, nor could I obtain the history of any horses suffering from horse-pox on the neighbouring farms. The only information which could be obtained, which was very suggestive, was that the milkers were in the habit of receiving their friends from neighbouring farms on Sundays. The friends would assist in the milking, to get the work done as quickly as possible on these occasions. As it was reported that the same disease had occurred that summer on a neighbouring farm, it is quite possible that it was introduced by one of the milkers' friends.

Mode of Dissemination.—When the disease made its appearance at farm W, the bailiff, attributing it to the farm being for some reason unhealthy, decided to remove the cows to other farms. The herd was therefore divided into two, and some of the animals were sent to farm X, and the rest to farm Y. From these cows the disease was communicated to the healthy cows, and, as this interchange was repeated, not only of the cows, but of the milkers, the disease was communicated to all the separate farms W, X, Y, and Z.

In all cases the disease was limited to the teats, and was conveyed from the teats of a diseased cow to the teats of a healthy cow by the hand of the milker. In no case was there any evidence of the disease being produced in healthy cows by other means than contact.

Bulls and dry cows remained free from the disease, while the cows in milk, numbering about 120, were all attacked, with the exception of about a dozen, which proved to be entirely refractory.

These facts explain how it is that the disease has been known from time immemorial as the "*cow*-pox." We never read of *cattle*-pox or *bull*-pox. We have not, in other words, to deal with an infectious disease like cattle-plague or pleuro-pneumonia, but with a disease which is communicated solely by contact.

The disease was only observed in the cows in milk, and was limited to the parts which come in contact with the hand of the milker. But it must not be imagined that we have necessarily to deal with retro-vaccination from the vesicles on a milker's hands. The virus was mechanically transferred from diseased to healthy cows, being communicated to all, or nearly all, the animals in the same shed, whether the milker had vesicles on his hands or not.

Character of the Eruption on the Cow.—After several visits to the farms I was able to obtain a history of the eruption on the cow's teats, and to study more particularly its later stages. It was only on the occasion of my first visit that I had an opportunity of seeing a cow with the early stages of the eruption. The hope of seeing fresh cases on future visits was not fulfilled. In spite of the closest examination, I could find nothing more than the remains of broken and dried vesicles, and the more or less characteristic crusts on the teats.

The animal I refer to was especially pointed out on the occasion of my first visit as the most recent case which had been observed. I had, however, little opportunity of examining her. The cow being, as the cowman described it, "very wild," was approached with extreme caution, and there was no chance of handling the teats. The teats were visibly inflamed, partly red and partly livid in colour. On each teat there were vesicles, some broken, and others appeared to be just forming. At other spots the crusts were already advanced.

After noting these points the idea of further examination was abandoned, and it was resolved to return again to continue the observations, and to make drawings under more favourable circumstances.

On subsequent visits I could only find the later stages of the eruption to study, and I had to rely for the early history on the description given me by the milkers. (Plate I.)

On visiting a byre at the time that the cows were brought in to be milked, it was a striking sight to look along the line and see one animal after another affected with the eruption, and thus one character of the disease was fixed in one's mind—the tendency to spread through a whole herd.

On examining the eruption carefully, the degree of severity was found to differ very much in different animals. In a few cases the condition was most distressing, both to the cow and to the observer. In such cases the teats were encrusted with huge dark-brown or black crusts, which, when handled in milking, were broken and detached, exposing a bleeding, suppurating, ulcerated base. Such ulcers varied in size from a shilling to a florin, and in form were circular, ovoid, or irregular. Weeks afterwards, when the animals had recovered, the site of these ulcers would be marked by irregular scars.

All the milkers agreed as to the general characters of the malady, laying particular stress on the teats being red, swollen, and painful when handled. Vesicles would then appear on the teats, two, three, four, or more on each teat. They were soon broken in milking, and irritated into sores, which became covered with thick crusts. From four to six weeks elapsed before they had entirely healed. Other more observant milkers insisted that before the teats were red and swollen, spots or pimples first appeared which "came to a head like a blind boil." This head increased if it was not broken, which might be the case if it was situated between the bases of the teats, until it formed a "dismal-white blister" of the size of a fourpenny piece, or even larger.

General Symptoms in the Cow.—As to the general condition of the cows nothing abnormal was observed. They appeared in the best of health, and in only one particular was any difference from their condition in health stated to exist. This was, that in the majority of the cases there could be no doubt that the milk was diminished. This might escape notice by inexperienced milkers in any particular animal, but the total amount of milk supplied by the herd was considerably below the average. By a rough estimation the bailiff calculated that the diminished supply of milk, taking all the herds together, had entailed a loss of about £50.

History of the Eruption Communicated to the Milkers.—The most striking characteristic of this outbreak was the communicability of the disease to the milkers. At first I only had the opportunity of studying the characters of the eruption in its later stages, but on a subsequent visit I was fortunate enough to meet with a recent case, and was thus able to follow the successive stages. This milker, with vesicles which presented all the characters which have been described of the casual cow-pox, was taken to London and kept under observation. I will describe this case more fully than the others, but I will first of all enumerate the various cases in the order in which they first presented themselves to me, giving their history as much as possible in their own words.

Case I.—J. R., milker, informed me that he was the first to catch the eruption from the cows. He states that it came as a hard, painful spot, which formed "matter" and then a "big scab." He had been inoculated about seven weeks ago. He pointed to the scar which remained on his right hand. This scar presented the characters of an irregular cicatrix, indicating considerable loss of substance. He states that he had also two places on his back, where he supposes he had inoculated himself by scratching. He had continued milking ever since, but had had no "fresh places."

Case II.—W. H., milker. He states that he was inoculated from the cows about the same time as J. R. They were the two milkers of the herd in which the cow-pox first made its appearance. The eruption appeared in one place on each hand. He pointed to two irregular scars as the remains of the eruption.

Case III.—J. L., milker, states that he also caught the disease from the cows. On his right hand a spot appeared which formed a blister, then discharged matter and produced a bad sore. Lumps formed at the bend of his elbow and in his armpit. He lost his appetite, felt very poorly, and was obliged to leave off work for two or three days and stay at home.

He states that about a fortnight or three weeks afterwards, while milking a very bad case, a sore on his left hand, resulting from a wound with a rusty nail, became inflamed, and another place broke out at the tip of one of his fingers, but he was not poorly, nor did the lumps appear in his left armpit.

Case iv.—W. K. works on the farms, but was put on as a milker to take the place of one of the others with bad hands. After his fifth or sixth milking, that is to say about three days after first milking the cows, pimples appeared on his hands, which became blistered and then ran on to bad sores. He pointed to three irregular scars on the first and third fingers and palm of the right hand. Lumps appeared in his elbow and in his armpit, but he did not feel very poorly in consequence.

Case v.—J. F., milker, states that about a month ago he noticed spots which appeared on both hands. His fingers swelled and were painful. He says it came first like a pimple and felt hard. Then it "weeped out" water in four or five days. There were red marks creeping up to his arm. There was a sort of throbbing pain, and he could not sleep at night.

When I saw him, I found on the right hand a scar, but on the left hand there was an ulcer about the size of a shilling covered with a thick black crust. The crust was partially detached and exposed a granulating ulcer. It was in this stage the exact counterpart of the ulcers on the cow's teats.

Case vi.—W. H., jun., milker, states that he had both hands bad about a month ago. First the index finger of the left hand, and then the right hand on his knuckle and between the first and second fingers.

He says that it came up like a hard pimple, and the finger became swollen and red. After a few days it "weeped out" water and then matter came away. Both his arms were swollen, but his left arm was the worst.

About a fortnight after, he noticed kernels in his armpits, which were painful and kept him awake at night. His arms became worse, he could not raise them, and he had to give up milking. He also had had a "bad place" on the lower lip.

On examination, I found that the axillary glands were still enlarged and tender. He voluntered the statement that the places were just like the sore teats. (Plate II, Fig. 1.)

Case vii.—J. H., the bailiff's son, also milked the cows. He had a sore on the upper lid of his right eye and on his left hand. In both cases he had been previously scratched by a cat, and the scratches were inoculated from the cow's teats. The right hand also had been inoculated. The eruption broke out a fortnight ago. His hands were swollen, red, and hot. He felt very poorly and went to bed. Little spots like white blisters appeared on the back of his right hand. His mother remarked that they "rose up exactly as in vaccination." Thick dark brown scabs formed. He was very ill for two or three days, but did not send for a doctor. He had painful lumps at the bend of his arm and in the armpit. He gave up milking and had not taken to it since.

On examining him the thick crusts on his right hand were identical with the stage of scabbing in vaccinia. The scabs fell off in about three weeks to a month and left permanent depressed scars.

Case viii.—W. P., milker. This case was pointed out to me on the occasion of my visit on December 2nd, and is the only one in which I was fortunate enough to see the eruption in its earlier stages. The case was of such extreme interest that I took the lad to London on the following day. Dr. Curnow very kindly made arrangements for admitting him as a patient to Greenwich Hospital, so that we might have the advantage of keeping him under observation.

The history of this boy is as follows. He had taken the place of one of the other milkers who had vesicles on his fingers and had been obliged to give up milking. After the seventh time of milking he noticed a small pimple on his right cheek. This

occurred on Sunday, November 27th. The pimple became larger and, as he expressed it, "rose up like a blister."

On December 2nd, the date of my visit, I was at once struck by the character of the eruption. It presented a depressed vesicle with a small central yellowish crust and a tumid margin, the whole being surrounded by a well marked areola and considerable surrounding induration.

After making a coloured drawing of the eruption (Plate II, Fig. 2), I punctured the tumid margin and collected clear lymph in a number of capillary tubes.

After this I raised the central incrustation and pointed out to the inspectors who were present the crater-like excavation, from which lymph welled up and trickled down the boy's cheek.

On the following day the crust had re-formed and was studded with coagulated lymph. The areola became more marked, and on pricking the margin of the vesicle the contents were slightly turbid.

From this day the surrounding infiltration increased enormously, the whole cheek was inflamed, and the eyelids so œdematous that the eye was almost closed. There was enlargement of the neighbouring lymphatic glands. The crust which had re-formed thickened day by day, and on December 9th, when I took the boy to Sir James Paget, there was a thick reddish-brown crust, still bearing the character of central depression, situated on a reddened, raised, and indurated base (Plate II, Fig. 3).

From this date the surrounding induration gradually diminished. The crust changed in colour from dark-brown to black, and finally fell off on December 15th, leaving an irregular depressed scar. This scar, when seen several months afterwards was found to be a permanent disfigurement.

Thus the eruption appeared on the fourth day after exposure to infection, and allowing two days for incubation, the vesicle was at its height on the seventh or eighth day, and a typical tamarind-stone crust fell off on the twenty-first day after infection, leaving a depressed, irregular cicatrix.

A vesicle also formed on the thumb of the left hand. Two days after the pimple appeared on his cheek, the lad says that he noticed a pimple on his thumb, and this, on my visit on December 2nd, presented a greyish flattened vesicle, about the size of a sixpence. On the following day its vesicular character was much more marked, and a little central crust had commenced to form. (Plate II, Fig. 4). On the Sunday, especially towards the evening, the margins became very tumid, giving it a marked appearance of central depression. On Monday, December 5th, in the presence of Dr. Curnow and the sister of the ward, I punctured the vesicle at its margin with a clean needle, and from the beads of lymph which exuded I filled a number of capillary tubes. This lymph was used the following morning for retro-vaccinating four calves.

On Wednesday, December 7th, suppuration had commenced; the vesicle contained a turbid fluid, and the areola was well marked. (Plate II, Fig. 5.) On December 9th the crust had assumed a peculiar slate-coloured hue, and, on pressing it, pus welled up through a central fissure. (Plate II, Fig. 6). The areola had increased, and there was considerable inflammatory thickening. The lymphatic glands in the armpit were enlarged and painful. Though there was deep ulceration, which left a permanent scar, the ulceration did not assume quite so severe a character as in some of the other milkers. Possibly this may be accounted for to some extent by the fact that the pock was covered with a simple dressing instead of being subjected to the irritation and injury incidental to working on the farm.

Revaccination of the Milkers.—The bailiff's son (Case VII) was shown at the Pathological Society on January 17th, nine weeks after he had become inoculated from the cows. On the afternoon of the same day (Tuesday), he was vaccinated by Dr. W. J. Collins, in the presence of Mr. Wilson, veterinary surgeon, with lymph taken direct from a child's arm. This child had beautifully correct vesicles, first remove from the calf.

On the second and third days there was topical redness at the places inoculated, but this rapidly subsided.

On the following Monday the boy was shown to Dr. Curnow and Professor Brown, and on the same day he returned to the farm, where he was able to report and demonstrate the failure of the vaccination. The news rapidly spread over the farm, and, as a result, his companion milkers volunteered, and others consented, to be submitted to the same test. The question then arose as to how this could be accomplished. I had intended to take lymph in tubes and vaccinate the men myself, but this idea was dismissed because I felt that as they would be cases of revaccination, it was advisable to obtain the services of a successful public vaccinator; and, secondly, it was necessary to avoid any fallacies which might arise from the use of stored lymph. Under these circumstances, I determined to apply to the local public vaccinator to vaccinate and report on the matter. Mr. Langley, of Cricklade, kindly consented, if I would select seven cases, to vaccinate them direct from children with typical vaccinal vesicles. I will not enter into any details as to the difficulties which had to be encountered in collecting these men from farms two or three miles apart, in arranging for their escort to Cricklade, some five miles distant; but I desire to express my thanks most cordially to Mr. A. and his bailiff for allowing me to make these arrangements, so interrupting to the work of the farms, and to Mr. Langley for undertaking the task of revaccination. The six men available were:—W. P., W. H., J. F., W. K., J. L., and J. R. Lastly, W. W., who had escaped inoculation from the cows accompanied us. The vaccination took place on February 1st, and the results were carefully watched, and are shown in the certificate which I received from Mr. Langley:—

Name.	Age.	Vaccine Cicatrices.	Result of Revaccination.
W. P.	23	1, left arm	None.
J. F.	18	3, right arm	None.
W. H.	17	3, left arm	None.
W. K.	22	3, left arm	None.
J. L.	24	2, left arm 2 (of revaccination at 15), right arm	None.
J. R.	55	3, right arm	None.
W. W.	58	None (states he was vaccinated in infancy)	One place, apparently true vaccine vesicle.

I hereby certify that I vaccinated the above men with the results here stated.

(Signed) Noah Beldon Langley, Public Vaccinator,
Cricklade District, Cricklade and Wootton Bassett Union.

W. W.'s case is of extreme interest. I had anticipated that, as he had escaped inoculation from the cows, he also would not take. He, however, was vaccinated with success, so that his escape while milking the cows could not be attributed to his having had the cow-pox when a milker twenty years previously. He was one of three who escaped, and one of the remaining two,

C. P., attributed his escape to the fact of his having had cow-pox twenty-five years previously, while the third milker, who escaped, F., senior, had never contracted cow-pox at all.

It was not only interesting, under the circumstances, that the vaccination of W. should have taken so well, but it afforded evidence of the active property of the lymph, and he constituted a control experiment to the six milkers who had suffered from the casual cow-pox, and in whom revaccination was without result. To make the experiment of revaccination as complete as possible, I determined to vaccinate the two milkers who had not been able to accompany me to Cricklade. These were W. H., aged 42; C. P., aged 64.

They had both been vaccinated in infancy. W. H. had on his arm three small pigmented patches and C. P. three marks. I employed Dr. Warlomont's lymph from three tubes. There was considerable topical irritation, in W. H. in one place, which gradually disappeared; while in C. P. all three places developed into angry looking wounds with unhealthy discharge, an appearance which at first, considering the age of the patient, caused me considerable anxiety.

To sum up, there were in all eight milkers, varying in age from seventeen to fifty-five, who had vesicles on their hands from milking the cows. Seven had been vaccinated in infancy, but not since; one had been revaccinated on entering the navy at fifteen. They were all revaccinated after complete recovery from the casual cow-pox (that is to say, from three to four months afterwards), and were all completely protected. On the other hand, two of the three milkers who had escaped infection from the casual cowpox were also vaccinated, with the result in W. W. of typical revaccination, in C. P. of very considerable local irritation.

Jenner was of opinion that cow-pox did not protect against cow-pox, but there can be no doubt, from these experiments, that cow-pox does protect against itself, for a time, though the duration of that time does not appear, even at the present day, to be satisfactorily determined.[1]

As I have already stated C. P. and W. W. both attributed their escape when the cows were attacked to their having caught the cow-pox, one twenty and the other twenty-five years ago, but as W. W. was re-vaccinated with success, and as F., senior (who had never had the cow-pox) also remained free from the disease, the escape of these men must be attributed to some other cause. Possibly the skin on the hands of these veteran milkers was not in such a favourable condition for receiving the virus.

Retro-vaccination of Calves.—I have mentioned that on Monday, December 5th, I collected lymph from a vesicle on the hand of W. P., and the following morning, without loss of time, I vaccinated four calves. This boy, it will be remembered, stated that he first noticed a pimple on his thumb on Tuesday, so that, allowing two days for incubation, the lymph was taken from his thumb about the eighth day. In all cases, the belly of the calves was shaved, and the skin sponged and cleansed with warm water, and wiped dry with a clean cloth. The vaccination was made by blowing the lymph on the point of a new scalpel. The skin was

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1 Un fait des plus intéressants que le service municipal de la vaccine à Bordeaux a mis le premier en lumière, c'est la nécessité des revaccinations dans les écoles primaires. Chez les écoliers vaccinés avec succès dans la petite enfance, les revaccinations peuvent déjà donner à partir de six ans 38 per cent. de succès: sur près de 8,000 écoliers de six a quatorze ans, la moyenne des succès obtenus a été de 41 per cent. Ces revaccinations d'écoliers comparées aux revaccinations chez des adultes nous ont amené aux remarques suivantes: La durée de l'immunité est variable suivant les individus; elle est variable aussi suivant les âges.—Layet.

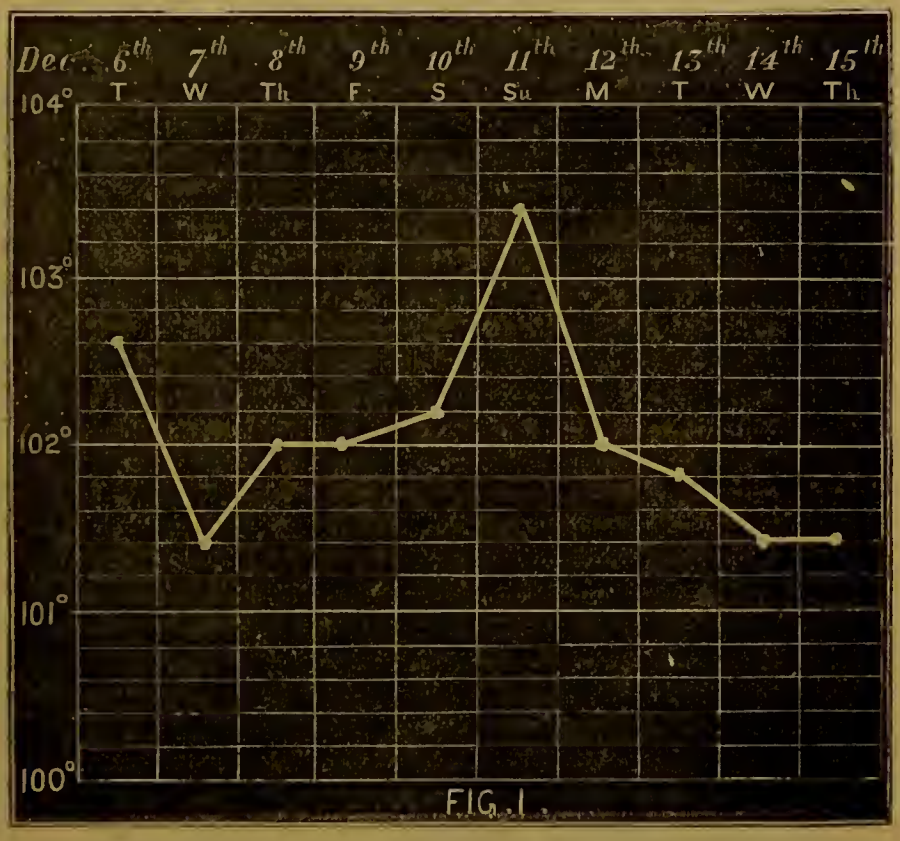
put on the stretch by an assistant, and a number of scratches and cross-scratches were made, as in the ordinary process of vaccination of infants, as superficially as possible, to avoid hæmorrhage.

The following are the details of the results which were obtained:

First Series of Retro-vaccinated Calves.

Calf 1, a small red calf, was vaccinated in six places. Next day a little dried serum had collected at the points of inoculation. The scratches were slightly reddened. The serum rubbed off in the course of a day or two, and there was no result from the retro-vaccination.

Calf 2, a large red calf, was inoculated in six places. On the third day each place was promising. On the fourth day, Friday, December 9th, each place was tumid, reddened, and vesiculating.



Temperature chart of retro-vaccinated calf (No. 2, red calf).

The results were shown to Professors Brown and Axe and to Dr. Curnow. On the following day, these appearances were more marked; the areola had considerably increased. There was infiltration extending around the inoculated spot for a distance of half an inch, and the discharge from the vesicle was turbid. On Monday, the 12th, brown crusts had formed, and, on pressure, pus appeared at the edges from underneath the crusts. The temperature of this animal is shown in Chart 1.

Calf 3 was a small red calf. This calf was vaccinated in six places. No result followed the vaccination except topical irritation.

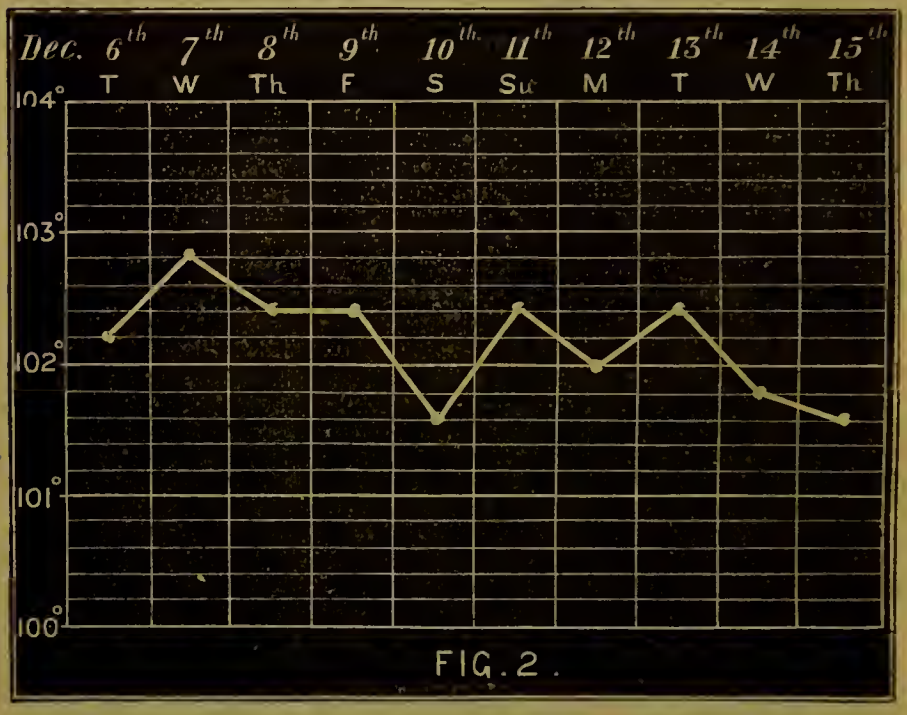
Calf 4, a blue-roan calf, was suffering from a severe attack of ringworm, consisting of thick eczematous-looking crusts on the side of the face and neck, along the back, and especially at the root of the tail. Similar results to those in Calf 2 occurred in all

of ten places which were retro-vaccinated. The temperature is shown in Chart 2.

Thus, in two out of four calves, there were positive results. In both animals the crusts gradually thickened, and, on December 16th, there were still thick dark-brown crusts and some remaining induration.

The large red calf (No. 2), on December 20th, was sent to the Animal Vaccine Station of the Local Government Board, as it had been proposed to ascertain the result of a revaccination with lymph derived from the Bordeaux cow-pox, as soon as the animals had recovered from the retro-vaccination.

On Thursday, December 28th, the places of inoculation were represented by depressed permanent scars. The calf was vaccinated by the Director in three places by linear incisions, two of which bled freely, and by myself in three places, by scarification



Temperature chart of retro-vaccinated calf (blue-roan calf, No. 4).

by the method originally employed. Lymph was taken direct from the arm of a child selected with typical vesicles. The child had been vaccinated with calf-lymph at the institution.

On the second and third day there was slight redness at the three incisions, but no trace of vesiculation. At the three places inoculated by myself there was a collection of dried serum, with similar topical irritation.

On Monday, January 2nd, the incisions had completely dried up, being marked by small, dry linear scabs, and in the scarified places the dry serum crumbled away to the touch. Thus, the revaccination of Calf 2 had totally failed.

On December 30th, the blue-roan calf also presented a number of permanent depressed cicatrices. This calf had been retained at the Royal Veterinary College, and, assisted by Mr. Wilson, I vaccinated the calf with calf-lymph, obtained from Dr. Warlomont, in the presence of Professor Brown. The lymph was copiously applied in three places thoroughly scarified, the contents of two tubes being mixed and rubbed into each scarification.

Professor Brown on this occasion pointed out the extremely contagious character of the cutaneous eruption, and warned me against handling the animal. On the same day we found that the attendant had actually been infected, his left arm being covered with a characteristic rash.

On the next day there was slight topical redness on each place of inoculation.

On the Monday, January 2nd, the scrum crumbled away to the touch, and the result of revaccination was a complete failure.

Thus, both calves which had been successfully vaccinated from the boy's thumb were revaccinated without success.

As it was urged that calf-lymph should have been used in vaccinating the first case, and, secondly, that six places were not sufficient, I resolved that this calf should again be vaccinated, and this time with calf-lymph direct from the calf. This was performed by the Director (Dr. Cory) in forty places on Thursday, December 12th; and it was agreed that Dr. Cory, Dr. Klein, and Mr. Murphy, should meet me on Sunday, December 15th, at 3 P.M. On examining the calf, there was no trace of success. Dr. Klein expressed an opinion that the eruption might yet appear. Mr. Murphy thought that the eruption might be retarded by the cold weather; but the following days not the slightest trace of eruption appeared in a single incision, and the animal had to be acknowledged as being completely protected.

It was then urged in the case of the blue-roan calf that as stored lymph had been used, this might be a source of fallacy. I therefore resolved to apply the test again, and to avoid any such fallacy I consented to allow this calf, which had now completely recovered from the ringworm, to be transferred from the Royal Veterinary College to the Animal Vaccine Station. After its arrival the Director stated that he was unable to allow me to vaccinate the animal or to remove it, on the ground that he had not received his instructions from his superior officer. This finally resulted in the animal being kept another fortnight, so that the vaccination was postponed until February 2nd, or nearly two months after the original inoculation. The calf was then vaccinated in thirty incisions by the Director and three scarifications by myself. On the second day, Saturday, most of the incisions presented, instead of the usual faint linear blush, a vivid inflammatory redness with considerable tumidity. On the Monday following a few places showed vesiculation at its height, and there was no doubt that the vaccination had taken with an accelerated course. On the following Thursday I returned to collect lymph and make cultivations, when I found that every incision had completely dried; every place of inoculation was marked by a dry linear scab to which I drew the attention of the Director. In fact a modified result was produced marked by considerable topical irritation, early vesiculation, and complete dessication on the seventh day. The explanation appeared to be that owing to the existence of the ringworm, the local appearances of vaccinia were produced at the time of the original inoculation without affording complete constitutional protection (see Chart 2) and that this limited protection had passed off by the time of the second re-vaccination which, as we have seen, was postponed until two months (fifty-eight days) after the original inoculation.

Second Remove of Calves.—From the calves which had been successfully retro-vaccinated I decided to carry on successive vaccinations, and I applied for some more animals. Unfortunately there were no calves ready for use, but they were ordered for me, and I had to postpone the operation until they were received on Monday, December 12th. On arriving at the Royal Veterinary

College I then found that the pocks of the original calves were suppurating; I nevertheless determined to ascertain what the result of inoculation would be. Three calves were therefore inoculated in the following way:—After detaching a brown crust some of the pus was collected on a scalpel and rubbed by scarification into the belly of two of the calves and inoculated by puncture in the vulva of the third.

Calf A., Series 2, was inoculated in six places in the belly. At each place there were positive results, but vesiculation was scarcely visible, and suppuration had commenced very early. On the evening of the fourth day, December 15th, this calf was shown by request at the special meeting of the Pathological Society. Each place of inoculation was pustular and covered with a brown scab. On Friday, December 16th, the crusts were raised, there was a well-marked inflammatory redness, and considerable thickening. On examining the crusts, there was pus underneath and an ulcer, with a slight tendency to bleed at the edges when pressed. On Saturday, December 17th, the inflammatory areola was less marked on each. Monday, December 19th, the crusts were thickening and areola disappearing, and there was a considerable amount of purulent discharge on squeezing the ulcer. On Tuesday, December 20th, this calf was also sent to the Animal Vaccine Station.

Similar results occurred in *Calf B.*, and no result in *Calf C.* Calves A. and B., series 2, were, on recovery, revaccinated with success.

Third Remove of Calves.—Before the departure of Calf A., I inoculated two small steers in some thirty places with pus from one of these pustular pocks. I made linear incisions in the manner employed at the Animal Vaccine Station. On Thursday, 22nd, the third day, there was vivid redness of the incision, and slight tumidity. On December 23rd suppuration had occurred. Thus again we had a similar result of early suppuration. One of the calves looked dull, refused food, and died on January 2nd. From the *post-mortem* examination there could be no doubt that the calf died of septicæmia.

Thus the result of retro-vaccinating calves with humanised lymph was in accordance with the results obtained by Ceely, for two cases out of four succeeded, and an eruption was produced with all the typical characters of vaccinia, but running rather a rapid course, [2] while the result obtained in the second and third

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[2] Thus corresponding with the experience of Ceely, who has pointed out that in retro-vaccination from the milker's hands the results are doubtful and depend greatly on the animals selected. "Those of a light colour and with thin skins were generally preferred, but often without avail, scarcely one-half of the operations succeeding." Again, in speaking of some of his experiments, Ceely says: "The above experiments will serve to show the greater difficulty of vaccinating the cow with humanised than with primary lymph, and that, when successful, a much milder disease is the result. Take an abundance of lymph from one of the finest and most protective vesicles ever seen, and if you succeed in retro-vaccinating the cow you may perhaps be able to charge only a very few points from a vesicle which excites but trifling topical inconvenience. Vaccine lymph it is obvious, therefore, in passing from the cow to man indicates a change which renders it less acceptable and less energetic on being returned to many individuals of the class producing it; some refuse it altogether." In the case of the second and third remove of calves, the postponement of the carrying on of the successive inoculations was probably the main cause of the production of spurious cow-pox, which is well-known not to be protective. Bryce, in his treatise on the cow-pox, has laid particular stress upon this point: "The fluid contained in the vesicle in the advanced stages of cow-pox has undergone a certain change, whereby it is rendered unfit for propagating this affection so as to give security from true small-pox, and this change is said to be marked by the puriform appearances which the fluid then assumes.....The areola is fully formed, and this is said to be a mark that the virus begins to be less active, therefore improper for use." It must also be remembered that the calves were retro-vaccinated with the lymph of a revaccination.

series was in accordance with what is well known to occur if lymph is not taken at the right stage for carrying on successive vaccinations.

However disappointing these results may appear, they are intensely instructive. They illustrate what is well known to occur in Animal Vaccine stations—the liability to rapid degeneration of vaccine lymph, if not taken on the right day, for carrying on calf-to-calf vaccination. Thus, starting with perfectly correct vesicles, if the lymph from these vesicles is not taken from selected vesicles at the right stage, in the course of two or three removes the lymph may be entirely lost. It will then become necessary to return to stock in order to start again a fresh series of vaccinations. It is on this account that, in order to carry on calf-to-calf vaccination, typical vesicles are selected, usually on the morning of the fifth day, and well-conditioned animals employed as subjects for the operation.

We learn from this that lymph cannot be trifled with. It must be *nursed*, or, so to speak, *cultivated*, with the greatest care; and if, in spite of these precautions, vesicles develop which have not the right standard of excellence, a return must be made to lymph in stock, which can be relied upon to yield the desired result.

It is much to be regretted that I had no opportunity of inoculating calves direct from the *vesicles* on the cow's teats; but it must be borne in mind that, at the early stage of the inquiry, my attention was completely directed towards ascertaining whether this disease produced scarlet fever or not, and such inoculations as were performed direct from the cow were made, as in Dr. Klein's experiments, with septic matter taken from the ulcers on the teats of a cow which had been sent to the Royal Veterinary College. When the nature of the disease revealed itself by the character of the eruption on the hands of the milkers, the time had not only gone by for collecting lymph from the vesicles on the cow's teats, but even for finding serviceable crusts.

I will now pass on to give, for purposes of comparison, an account of cow-pox as we have received it from Jenner and other writers on this subject.

Jenner's Description of Cow-Pox.

I cannot, perhaps, do better than quote verbatim from Jenner's essay.

"There is a disease to which the horse, from his state of domestication, is frequently subject. The farriers have termed it the grease. It is an inflammation and swelling in the heel, accompanied at its commencement with small cracks or fissures, from which issues a limpid fluid possessing properties of a very peculiar kind. This fluid seems capable of generating a disease in the human body (after it has undergone a modification I shall presently speak of) which bears so striking a resemblance to the small-pox that I think it highly probable it may be the source of that disease. In this dairy country a great number of cows are kept, and the office of milking is performed indiscriminately by men and maid servants. One of the former having been appointed to apply dressings to the heel of a horse affected with the malady I have mentioned, and not paying due attention to cleanliness, incautiously bears his part in milking the cows with some particles of the infectious matter adhering to his fingers. When this is the case it frequently happens that a disease is communicated to the cows, and from the cows to the dairymaids, which spreads through the farm, until most of the cattle and domestics feel its unpleasant consequences. This disease has obtained the

name of the cow-pox. It appears on the nipples of the cows in the form of irregular pustules. At their first appearance they are commonly of a palish blue, or rather of a colour somewhat approaching to livid, and are surrounded by an inflammation. These pustules, unless a timely remedy be applied, frequently generate into phagedænic ulcers, which prove extremely troublesome. The animals become indisposed, and the secretion of milk is much lessened. Inflamed spots now begin to appear on different parts of the hands of the domestics employed in milking, and sometimes on the wrists, which run on to suppuration, first assuming the appearance of the small vesications produced by a burn. Most commonly they appear about the joints of the fingers and at their extremities; but, whatever parts are affected, if the situation will admit, these superficial suppurations put on a circular form, with their edges more elevated than their centre, and of a colour distantly approaching to blue. Absorption takes place, and tumours appear in the axilla. The system becomes affected; the pulse is quickened; shiverings, succeeded by heat, general lassitude, and pains about the loins and limbs, with vomiting, come on. The head is painful, and the patient is now and then even affected with delirium. These, sometimes varying in their degrees of violence, generally continue from one to three or four weeks, leaving ulcerated sores about the hands, which, from the sensibility of the parts, are very troublesome, and commonly heal slowly, frequently become phagedænic, like those from whence they sprung. During the progress of the disease the lips, nostrils, eyelids, and other parts of the body are sometimes affected with sores, but these evidently arise from their being heedlessly rubbed or scratched with the patient's infected fingers. No eruptions on the skin have followed the decline of the feverish symptoms in any instance that has come under my inspection, one only excepted, and in this case a very few appeared on the arms. They were very minute, of a vivid red colour, and soon died away without advancing to maturation; so that I cannot determine whether they had any connection with the preceding symptoms. Thus the disease makes its progress from the horse (as I conceive) to the nipple of the cow, and from the cow to the human subject."

I will pass over the earlier writers on cow-pox, who add very little to the account which was given by Jenner, until we come to the year 1840, when Ceely published his classical researches, the details of which are not so well known as they ought to be, probably owing to the fact that the volumes of the *Transactions* in which they are published are only to be found in some of our larger libraries. I shall not, therefore, hesitate to quote somewhat at length from his account of cow-pox.

Ceely's Description of Cow-Pox.

Ceely states that this disease had long been known in the Vale of Aylesbury and neighbourhood. Outbreaks occurred at irregular intervals, most commonly appearing about the beginning or end of the spring; rarely during the height of summer. Ceely saw outbreaks at all periods, from August to May and the beginning of June; and he tells us that he had seen the disease in autumn and the middle of winter, after a dry summer. The disease, in his time, was occasionally epizootic, or occurring at times in several farms at no great distance from each other, but more commonly sporadic or nearly solitary. It was to be seen sometimes at several contiguous farms; at other times at one or two farms. Many years might elapse before it occurred at a given farm or vicinity, although all the animals

might have been changed in the meantime. Ceely knew of its occurring twice in five years in a particular vicinity and at two contiguous farms, while at a third adjoining dairy, in all respects similar in local and other circumstances, it had not been known to exist for forty years. It was sometimes introduced into a dairy by recently-purchased cows. Twice it had been known to be so introduced by milch heifers. Ceely states that it was considered that the disease was peculiar to the milch cow; that it came primarily while the animal was in that condition, and that it was casually propagated to others by the hands of the milkers. And he adds that he had frequently witnessed the fact that sturks, dry heifers, dry cows, and milch cows, milked by other hands grazing in the same pastures, feeding in the same sheds and at contiguous stalls, remained exempt from the disease.

Origin of Cow-pox.—Ceely states that he had met with several intelligent dairymen whose relatives had seen good reason to ascribe its occurrence to the contagion of the equine vesicle communicated by the hands of the attendant on both animals, but very little of that disease had been noticed of late years, though he knew several farriers who had been infected from the horse, and received subsequent variolation or vaccination. He had seen also a few who distinguished between the equine vesicle and the grease—a recurrent disease, eczema impetiginodes. For many years past, however, the spontaneous origin of the "variolæ vaccinæ" in the cow had not been doubted in the Vale of Aylesbury. In all the cases that Ceely had noticed he never could discover the probability of any other source. "There is much difficulty in determining with precision at all times whether this disease arises primarily in one or more individuals in the same dairy. Most commonly, however, it appeared to be solitary. The milkers pretend in general to point out the infecting individual."

Condition of Animal Primarily Affected.—"In August, 1838, three cows were affected with the disease. The first was attacked two months after calving and seven weeks after weaning. This animal was considered in good health, but to me it appeared out of condition. It had heat and tenderness of teats and udder as the first noticed signs. The other two were affected in about ten days. In December, 1838, in a large dairy, a milch cow slipped her calf, had heat and induration of the udder and teats, with vaccine eruption, and subsequently leucorrhœa and greatly impaired health; the whole dairy, consisting of forty cows, became subsequently affected and some of the milkers. In another dairy, at the same time, it first appeared in a heifer soon after weaning, and in about ten or twelve days extended to five other heifers and one cow, milked in the same shed, affecting the milkers. In another dairy, at the same time, thirty cows were severely affected, and also one of the milkers. It appeared to arise in a cow two months after calving. The only symptoms noticed were that the udder and teats were tumid, tender, and hot just before the disease appeared."

Condition of Animals Casually Affected.—"In some animals it is less severe than in others, depending on the state and condition of the skin of the parts affected, and the constitution and habit of the animal. It is sometimes observed to diminish the secretion of milk, and in most cases it commonly does actually affect the amount artificially obtained; beyond which, and the temporary trouble, plague, and accidents to the milk and the milkers, little else is observed; the animal continues to feed and graze apparently as well as before. The topical effects vary very much in different individuals

...the mildness or severity being greatly influenced by temperament and condition of the animal, and especially by the state of the teats and udder and the texture and vascularity of the skin of the parts affected. Where the udder is short, compact, and hairy, and the skin of the teats thick, smooth, tense, and entire, or scarcely at all chapped, cracked, or fissured, the animal may and often does escape with a mild affection, sometimes only a single vesicle. But where the udder is voluminous, flabby, pendulous, and naked, and the teats long and loose, and the skin corrugated, thin, fissured, rough and unequal, then the animal scarcely ever escapes a copious eruption. Hence in general heifers suffer least and cows most from the milkers' vaccinations and manipulations."

Progress of the Disease.—"The variolæ vaccinæ once arising or introduced, and the necessary precautions not being adopted in time, appear in ten or twelve days on many more in succession, so that among twenty-five cows perhaps by the third week nearly all may be affected; but five or six weeks or more are required to see the whole number perfectly free from the disease—on the teats at least."

Propagation by the Hand of the Milker.—Ceely gives the following instances in which he most thoroughly traced the way in which the disease was spread:—"In December, 1838, on a large dairy farm, where there were three milking-sheds, the variolæ vaccinæ first appeared in the home or lower shed. The cows in this shed being troublesome, the milker from the upper shed, after milking his own cows, came to assist in this for several days, morning and evening, when in about a week some of his own cows began to exhibit the disease. It appears that, having chapped hands, he neglected washing them for three or four days at a time and thus seemed to convey the disease from one shed to another. During the progress of the disease through this shed, one of the affected cows which had been assailed by its fellows was removed to the middle shed where all the animals were perfectly well. This cow, being in an advanced stage of the disease, and of course difficult to milk and dangerous to the milkpail, was milked first in order by the juvenile milker for three or four days only, when, becoming unmanageable by him, its former milker was called in to attend exclusively to it. In less than a week all the animals of this shed showed symptoms of the disease, though in a much milder degree than it had appeared in the other sheds, fewer manipulations having been performed by an infected hand."

Topical Symptoms of the Natural Disease.—"For these, we are almost always in the early stage compelled to depend on the observations and statements of the milkers....They state that for three or four days, without any apparent indisposition, they notice heat and tenderness of the teats and udder, which are followed by irregularity and pimply hardness of these parts, especially about the bases of the teats and adjoining the vicinity of the udder; that these pimples on skins not very dark are of a red colour, and generally as large as a vetch or a pea, and quite hard, though in three or four days many of these having increased to the size of a horse-bean. Milking is generally very painful to the animal; the tumours rapidly increase in size, and some appear to run into vesication on the teats and are soon broken by their hands. Milking now becomes a troublesome and occasionally a dangerous process. It is very seldom that any person competent to judge of the nature of the ailment has access to the animal before the appearance of the disease on others of the herd, when the cow first affected presents on the teats acuminated, ovoid, or globular vesications, some entire, others broken, not infrequently two or

three interfluent, *those broken* have evidently a central depression with marginal induration; those entire, being punctured, diffuse a more or less viscid amber-coloured fluid, collapse, and at once indicate the same kind of central and marginal character. They appear of various sizes, from that of a pin's head, evidently of later date, either acuminated or depressed, to that of an almond or a filbert, or even larger. Dark brown or black solid uniform crusts, especially on the udder near the base of the teats, are visible at the same time, some much larger are observed on the teats; these, however, are less regular in form and less perfect. Some are nearly detached, others quite removed, exhibiting a raw surface with a slight central slough. On the teats the crusts are circular, oval, oblong, or irregular; some flatter, others elevated, some thin and more translucent, being obviously secondary. The appearance of the disease in different stages, or at least the formation of a few vesicles at different periods, seems very evident. The swollen, raw, and encrusted teats seem to produce uneasiness to the animal only while subjected to the tractions of the milkers, which it would appear are often nearly as effective as usual." Referring again to the character of the vesicle, Ceely says that those "fortunate enough to have an opportunity of watching the disease in its progress may observe that when closely examined they present the following characters:—In animals of dark skin, at this period, the finger detects the intumescent indurations often better than the eye, but when closely examined the tumours present at their margins and towards their centres a glistening metallic lustre or leaden hue; but this is not always the case, for occasionally they exhibit a yellowish or yellowish-white appearance."

In describing more fully the crust, he adds, "large, black solid crusts, often more than an inch or two in length, are to be seen in different parts of these organs, some firmly adherent to a raw elevated base, others partially detached from a raw, red, and bleeding surface; many denuded, florid, red, ulcerated surfaces, with small central sloughs secreting pus and exuding blood, the teats exceedingly tender, hot, and swollen.....In some animals, under some circumstances, this state continues little altered till the third or fourth week, rendering the process of milking painful to the animal and difficult and dangerous to the milker.

"In many, however, little uneasiness seems to exist. The parts gradually heal; the crusts, although often partially or entirely renewed and renewed, ultimately separate, leaving apparently but few deep irregular cicatrices, some communicating with the tubuli lactiferi, the greater part being regular, smoothly-depressed, circular, or oval."

With regard to the papulæ, "the milkers seldom notice the first period of papulation. Nor is this to be wondered at. It is, in truth, very difficult for an experienced observer at all times to escape error in this latter particular, and oversights will occur to the most vigilant from various causes, especially from peculiarity of colour, vascularity and texture of skin, as well as temperament of the individual."

With regard to the central depression, Ceely says, "in three or four days from their first appearance the papulæ acquire their vesicular character, and have more or less of central depression, continuing gradually to increase. In three or four days more they arrive at their fullest degree of development, and sometimes are surrounded with an areola, and always embodied in a circumscribed induration of the adjacent skin and subjacent cellular tissue."

"Anatomical examination of the structure of the vesicle just before it attains maturity shows that its colour, indurated margin, and central depression depend on the existence of an adventitious membrane formed in the corium and secreted by the papillæ. It is raised in the form of a zone, and is intimately connected with the epidermis. It has a cellular structure in which is secreted and contained a clear viscid lymph.....*This cellular adventitious membranous conformation, though differing in texture and amount in different vesicles, is invariably present, and is not less essential than diagnostic.*"

Casual Cow-pox in Man.—"Although the casual cow-pox in man is mostly found in those who have not previously gone through variola or the vaccine, it is by no means rare to meet with it on persons who have passed through the latter and a few who have had the former disease. It is no novelty to see individuals who have taken the casual disease more than once at various intervals, but not severely; and now we often see cases after vaccination at periods of from two to fifteen years of different degrees of severity, not always but often proportioned to the time elapsed. Many declaring their symptoms to be more distressing than those which they remembered of the previous vaccination. On the other hand we now and then meet with persons who without any protection have used every endeavour to acquire the disease by milking but have failed amidst their more fortunate fellow-labourers. As in the cow so in man, it does not appear always necessary that the skin should be visibly fissured or abraded to insure infection, although very often we find those conditions in existence. A thin and vascular skin seems capable of absorbing lymph if copiously applied and long enough retained. The parts upon which the disease is commonly observed are the back of the hands, particularly between the thumb and forefinger, about the flexures of the joints and on the palmar, dorsal, and lateral aspects of the fingers. The forehead, eyebrows, nose, lips, ears, and beard, are often implicated from incautious rubbing with the hands during or soon after milking. In women the wrists and lower parts of the naked forearm coming in contact with the teats are apt to be affected. If the skin of the hands be very thin and florid, especially if chaps and fissures abound, the individual often suffers severely, having, soon after the decline of the disease, abscesses and sinuses of the subcutaneous cellular tissue and often considerable swelling and inflammation of the absorbents and the axillary glands. The inflamed spots or papulæ which announce the disease are more circumscribed, better defined, harder, deeper, and more acuminate, than the papulæ produced by some of the other contagious eruptions of the cow. They vary in colour from a deep rose to a dark damask or purple hue according to the vascularity and texture of the parts affected. If the papulæ be small there is often no perceptible central depression in the early period of their change to the vesicular state; but they exhibit an ash-coloured or bluish, rather acuminated apex which gradually becomes relatively flatter as the base enlarges and elevates, when the central depression is more obvious and exhibits a yellowish tinge....Where the epidermis is thick the vesicles are generally well-defined, circular or oval, if the parts will admit, and have only a light slate-coloured tint in the centre; but more frequently the colour is superseded by an opaque white, or a dusky-yellowish hue. Where the skin is loose, thin, dark, or dusky the vesicles are jagged, irregular and puffed at their margins, and, saving the central depression, very much resemble a scald. In size they vary from that of a vetch to a fourpenny piece, some-

times larger, especially when depending on a wound or extensive fissure. The vesicles are frequently broken, or when the epidermis is thin, spontaneously burst, causing deep sloughing of the skin and cellular tissue, and ulcerations which slowly heal. There is often, consequently, much attendant local irritation and considerable symptomatic fever....In general there is no great difficulty in distinguishing the casual vaccine on the hands, etc., from other eruptions caught from the cow."

Cow-pox in Germany.

I do not propose describing all the outbreaks of cow-pox which have been published in Germany, but I will allude briefly to some of them. After the publication of Jenner's writings, inquiries, which were set on foot, brought several outbreaks to light.

It appears from a Göttingen paper, published in 1769, that the disease was well known there, and milkers who contracted the disease in milking the cows had the same traditions as the dairy-maids in Gloucestershire as to its protective power against small-pox. Luders saw several outbreaks during eleven years in Holstein, and Ritter found that cow-pox, from which he carried on successful vaccination, was very common in Schleswig-Holstein. The account given of the inquiries in Wurtemberg as to the existence of cow-pox are of great interest. It shows that the discoveries of cow-pox depend upon the tact and zeal with which the disease is looked for. The tendency in this and other countries is for the cowkeeper and dairyman to keep secret for obvious reasons the existence of disease among their cattle. When a reward was offered by the Government for the discovery of cow-pox it was found during eleven years—1827-1837—in sixty-nine places, in such a state that successful vaccination could be performed.[3]

For a more detailed account I must refer to the work of Hering. I will only here draw attention to some of his conclusions, which are of interest in reference to this inquiry:—1, That cow-pox is frequently observed in Wurtemberg; 2, that it appears in all races of cows; 3, that retrovaccination from man to cow rarely succeeds; 4, that the general symptoms are often wanting in part or entirely. On the other hand, diminution and alteration of the milk usually occurs. 5, True cow-pox appears not only on the teats but also, though rarely, on the udder itself. The number of the pustules, their form and size, are very variable. The areola and central depression are often absent; the bluish or livid colour is not characteristic, a white or yellowish, silvery or pearly, colour is quite as common. 6, The structure of the pock is cellular; its contents at first clear, more or less viscid, later purulent, and then caseous. The lymph is only fully active in the first stage. If turbid lymph, and even crusts, give satisfactory results, without doubt it must be ascribed to the fact that they contain unchanged lymph in the liquid or dried state.

Cow-pox in France.

The accounts of cow-pox in France, which are of the greatest interest in connection with the Wiltshire outbreak, are the celebrated outbreak at Passy and the more recent cases at Bordeaux.

Passy Cow-pox.—The following is M. Bousquet's account of the discovery and characters of the Passy cow-pox:—On March 21st, 1836, Dame Fleury, living at Passy, consulted Dr. Perdran. She had been suffering for some days with headache and feverish

[3] In 1873 there were 39 cases in Wurtemberg; in 1874, 28. In Denmark in 1874 there were, in certain districts, not less than 374 cases. In Prussia cow-pox occurred during six years in 37 districts.

symptoms, and had three pustules on her right hand and another on her upper lip. Dr. Perdran, on seeing these pustules, asked what was her occupation. She replied that she milked cows and believed that she had contracted the eruption from them. Dr. Perdran had no doubt that the pustules on the hand were produced from cox-pox. Under this impression he mentioned the fact to M. Nauche, a vaccination expert. M. Nauche gave an opinion with some reservation, and sent on the case to M. Bousquet.

M. Bousquet's description of the eruption is as follows:—"Dame Fleury had three pustules on the right hand. One was situated over the articulation of the thumb, the second on the dorsal side of the ring-finger, the third on the internal aspect of the index-finger, the fourth on the upper lip, at the line of muco-cutaneous union. These pustules had a diameter of three to four lines. They were globular or somewhat spherical, prominent and well circumscribed. The pustule on the thumb had a certain irregularity, which consisted in its being larger in one diameter than the other. The three others were perfectly circular. The surface presented a yellowish or purulent appearance up to the edges, which were violet, and so was the areola with which they were surrounded. Nevertheless, the pustule, taken as a whole, showed a bluish tint, such as I had never seen. This recalled to my mind that Jenner gives this colour as the characteristic mark of cow-pox, and I was not surprised that a first remove should possess something of its origin. It is also worthy of mention that Jenner commonly described the joints of the fingers and the lips as the parts of the body where the accidental pustules are found. Beyond this, one would have some difficulty in recognising vaccinia by this description. Its classical characters were absent. There was no depression in the centre of the pustule, nor that brilliant and silvery appearance which forms a distinctive sign of the vesicular eruption. But these differences explained themselves partly by the advanced state of the pustules."

"We must also add that Dame Fleury informed us that she had had small-pox. She had no scars, except a small mark on the cheek which she pointed to as evidence of the correctness of her statements. However this may be, this circumstance was of little moment, at least it was not a reason for abandoning hope. Nothing is more common than to see vaccinia on those who have had small-pox." Bousquet quotes his own case. Still, this was conjectural, and there was only one way of deciding it, namely, inoculation of the matter of the pustules.

On March 21st, 1836, in the presence of a commission, nine children were vaccinated from Dame Fleury's pustules, and a stock of lymph was raised which was introduced into general use. When compared with the vaccine then current, it gave very much more satisfactory results.

Bordeaux Cow-pox: First Outbreak at Eysines, 1881.[4]—On November 17th, 1881, M. Landeau, doctor at Eysines, wrote the following letter to the prefect: "I have the honour to report to you a discovery which I have just made of a cow with cow-pox. On November 13th, an inhabitant of the village of Laforêt, in the commune of Eysines, came to consult me about an eruption which had appeared four days previously on the hand, on the face, and neck. This eruption showed several silvery pustules much flattened and depressed in the centre, surrounded with an areola which recalled to my mind the appearance of vaccine and the

[4] I am indebted to Dr. Dubreuilh, who kindly furnished me with this account.

question as to the cause of this cutaneous affection. This man informed me that among his cows there was one difficult to milk, having had on its teats for seven or eight days large *boutons*, from which pus escaped. Having been to verify this interesting subject, I became convinced that we had to do with cow-pox, the true regenerating principle of vaccine." On the 19th, M. Dubreuilh, public vaccinator for the Gironde, went to Dr. Pujos, and invited him to accompany him to Eysines.

Dr. Dubreuilh describes his visit as follows:—"We went to the village of Laforêt to see the milker alleged to have been inoculated from the cow. This man, aged 31, said that on November 11th, the first pustule appeared on the ring finger of the left hand. On the 14th, others appeared on his hand and face. He had suffered from lassitude and loss of appetite. These symptoms led him to consult M. Landeau. We were only able to see the cicatrices of these pustules. The cow suspected of communicating cow-pox to the milkman who milked her every day was in a field with six others. She was eleven years old. The pustular eruption was very characteristic, scattered on the teats and udder. On the day of our visit we only found crusts resembling the crusts of the pustules of variola. Six of these crusts were detached, two were still soft and moist. They were put between two slips of glass, and on our arrival at Bordeaux were entrusted to M. Duluc, the veterinary surgeon of the Department, who placed his services at our disposal. On November 26th, the first inoculation was made ; the crusts from the Eysines cow were triturated, some with glycerine, others with a little tepid water. Dr. Dubreuilh and Dr. Pujos undertook this in the presence of several persons, who met at M. Duluc's house. A commission was also asked for to follow the experiments.

First Inoculation, November 26th.—M. Duluc inoculated the vaccine of Eysines into a calf, aged 9 months, in the region of the belly, eighteen punctures being made, consisting of an equal number of the above-mentioned mixtures. The calf was kept under observation. "The two first days there was nothing particular to be noted in the punctures, but, on the evening of the third day, we observed around each puncture an areola, indicating that inflammatory action had commenced. On the fourth day there was an elevation of the epidermis, which gave promise of vesiculation, but which might have been the result of topical irritation."

"It was only on the evening of the same day that the characters became more marked, and an accumulation of serosity was formed at several punctures, but not yet sufficiently abundant or characteristic to show convincingly that the eruptions were truly vaccinal."

"It was really only on the fifth day that one could feel almost certain that we had to do with the eruption of cow-pox. Nearly all the punctures were raised, and perfectly circumscribed. A white ring surrounded the large crust of the cicatrices, resulting from the deep incisions which were made in order to introduce a large quantity of the liquid. By raising up the crust, and squeezing forcibly one of the pustules with the forceps, a limpid serosity escaped, of a white colour clouded with a yellowish tint."

On December 1st the swelling had subsided, the whitish ring had assumed a purulent character.

These inoculations were carried on through successive calves ; but it was not until the fourth remove that the vesicles were "fully formed with the character of umbilication." From the fifth remove, lymph was employed for vaccinating an infant. This child developed on each arm three large umbilicated vesicles,

surrounded with a very intense inflammatory areola. Other children were also vaccinated with similar results.

From the seventeenth remove, in answer to the written request of Dr. Buchanan, lymph was supplied for the Local Government Board, and since that time has been disseminated all over this country.[5]

It is to be regretted that Dr. Dubreuilh arrived, as nearly always happens to be the case, when the early stages of the eruption had passed off, as thus no description is given of the early characters of the natural disease in the cow. The only facts to guide him were the cicatrices of the casual eruption on the hand of the milker, and the production of a vaccinal eruption in calves which were inoculated with crusts from the cow's teats.

Second Outbreak at Eysines, 1883.—I will quote verbatim the report of M. Layet, April, 1883, the able Director of the Animal Vaccine Station at Bordeaux, to whom I am indebted for the following particulars:

"In my own name and in that of M. Baillet, veterinary surgeon of the town, I am about to give you an account of the experiments, undertaken in the municipal service, as to the nature and character of the eruption observed at Eysines, in three cows belonging to the farm of M. Lalanne, and in the milkman and milkmaid who were in contact with these cows. This multiple eruption was discovered and communicated to the Municipal Vaccine Service by Dr. Ducamp, of Bruges. In his letters, Dr. Ducamp expressed the opinion that it might be a case of spontaneous cow-pox. On receiving this letter, which had been placed in the hands of M. Darand on Thursday, March 22nd, 1883, at the Academy, a commission was appointed."

"This commission, in the first place, established the existence in the milkmaid of a pustule without well-marked characters, situated on the upper lip at the opening of the right nostril, which had produced erysipelatous inflammation, with fever, a disorder which compelled the patient to keep in bed."

"On being questioned she stated that she had inoculated herself by her finger conveyed to the part attacked."

"The milkman showed on the dorsal aspect of both hands a certain number of sores, which caused a swelling of the part—sores which had lost all character of a specific eruption in consequence of repeated friction and washing."

"The commission did not hesitate to ascribe, as the cause of his malady, the repeated contact with the teats of these cows, who were successively attacked by a particular eruption, which we were able to examine for ourselves on the spot."

"Of these three cows, the one which was stated by the milkman to have been attacked on the 12th of the month presented on its four teats numerous *boutons* of a character intermediate between a pustule and a bulla. The skin of these *boutons* had a greyish appearance, due, no doubt, to the character of the epidermis of the teats. By the side of these *boutons* we found, on examination, some shallow excoriations, oval, and two or three

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[5] This stock of lymph has been abandoned at the Animal Vaccine Station at Bordeaux; thus M. Layet informs me: "Le premier cow-pox d'Eysines signalé par M. le Docteur Laudeau à M. Dubreuilh recueilli sur une vache de Laforêt, qui avait presentée plusieurs eruptions successives n'a été employé que quelques mois par le service municipal de la vaccine a Bordeaux, lequel a depuis renouvelé son vaccin deux fois par du cow-pox spontané (portant le nom de deuxieme cow-pox d'Eysines et cow-pox de Cérons) et trois fois par du horse-pox envoyé au service municipal et provenant de differents points. Actuellement celui qui sert avec le plus grand succès provient d'un horse-pox remontant à 18 mois de culture."

larger ulcerated sores, none with any crusts—a fact attributed by the milkman to the manipulations in milking, and also to inunction of the teat with lard."

"A second cow presented analogous lesions of the teats, which appeared, according to the milker, three days after those of the first cow."

"A third cow showed vesico-pustules without concomitant ulceration. They had appeared four days after those of the second cow."

"We ought to add that none of the *boutons* examined presented the appearance of umbilication, and that some of the ulcerated pustules showed at their circumference some induration. M. Baillet and I immediately, in the presence of the members of the commission, collected, in a number of capillary tubes, the exudation coming from the eruption in the three cows."

"On our return to Bordeaux the commission met at the *abattoir*, where a calf was inoculated. This calf, vaccinated March 23rd, showed only at the end of eight days some slight elevation of the punctures of the size of the head of a pin. There were nineteen in all. The slight inflammatory appearance was observed indefinitely in all. From these elevations exudation was expressed by means of forceps, and a second calf was inoculated on March 30th, 1883. Fourteen punctures were made on the second calf."

"The first calf was revaccinated with current calf lymph, and *was not slow in showing a characteristic eruption, having acquired no immunity.*"

"The second calf remained until Thursday, April 5th, not showing the least sign of eruption. On the Thursday evening slight reddish elevations were noticed without much character. The next day the moment in which we were doubting the character of these elevations, and were on the point of sending this calf to the slaughter-house, a final examination showed on two points two characteristic vaccinal vesicles."

"The next morning, April 17th, fourteen punctures were made from these in a third calf. All these produced magnificent vaccinal vesicles."

The milkman and milkmaid who had caught the eruption were revaccinated, but only topical irritation was produced.

Cow-pox at Cérons.—December 26th, 1883, M. Barbe, veterinary surgeon, and Dr. Pichausel had discovered on an isolated cow an eruption which they believed to be cow-pox.

"December 26th, M. Baillet and others saw the cow. On the four teats and on the neighbouring part of the udder there was a considerable number of pustules, for the most part already dried and covered with a black crust, some containing a liquid more or less lactescent. This very confluent eruption did not offer any umbilication of the vesicles. Six or seven tubes of liquid were carefully collected."

"December 26th, on returning to Bordeaux a calf was inoculated with twelve punctures. On the third day three *boutons*, of which one was more advanced, offered the characters of the vaccinal vesicle. In the place of the other punctures there was only slight redness."

With all precautions a second calf was inoculated from two of these vesicles with thirteen punctures, and on January 4th there were thirteen successes. Moreover, on again examining the first calf. it was found that all the punctures had given place to a *bouton* more or less developed. Evolution had been obviously retarded."

"A third calf was inoculated in forty places, and this calf was

then used for the public service. M. Barbe found that on December 28th two persons who milked the cow at Cérons had contracted on their hands the eruption."

Such are the characters of the casual cow-pox, as it has been met with in this country and on the Continent, and these facts clearly show that in future the diagnosis of cow-pox must not be dismissed, after a comparison of the characters of the eruption on the teats with the classical characters of the inoculated disease, but only by vaccinating a calf and really ascertaining whether the eruption produces the vaccinal disease or not.[6]

To Raise a Stock of Lymph.—It is quite evident, also, from the account which I have just given, that the result which may be obtained by vaccinating a calf direct from the cow must not be despaired of if the eruption does not at once present the classical characters of vaccinia.

Ceely has pointed out that to obtain primary lymph in a condition for use is a task of no ordinary difficulty. "The most vigilant and active endeavours frequently prove unavailing. Unless the disease arises in a large dairy, and a consequent succession of cases occurs, it will seldom happen that vesicles are found capable of yielding that which is sought for. More frequently than would be expected the practitioner will have the mortification to find on his arrival that, from the lateness of his investigation, a whole dairy of cows has passed through the disease. He can scarcely find even a useful crust. If lymph from vesicles cannot be obtained, then we may yet succeed in taking one of the amorphous masses of concrete lymph, consisting of central irregular crusts, vesicular crusts, or dessicated vesicles. Mixtures of concrete blood and pus are of no value whatever." That the practitioner need not despair if he can procure a good crust is evidenced by the fact that the lymph employed by the Local Government Board was raised from a crust by Dr. Dubreuilh. If possible, a calf should be vaccinated with liquid or concrete lymph direct from the cow, and from this calf a second and a third, and if a vaccinal eruption results, the lymph may be introduced for variolous protection.[7] Lymph may be taken from a milker's

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[6] Thus M. Layet, in commenting on the cow-pox at Bordeaux, states the eruption observed on the cows did not present to the eyes of MM. Baillet and Peyronny any sign which would indicate the nature of the disease. There was nothing which less resembled the familiar vaccinal vesicle than the pustule on the milkmaid and the ulcerated sores observed on the milkman. Further, a commission appointed to inquire into these points reported: 1. The absence of the classical characters in the bullous eruption observed on the teats of the Eysine cows. 2. The analogy which exists between the bullæ of this eruption of cow-pox with the bullæ (ampoules perlées) of true horse-pox, to which M. Bouley has drawn attention, and between the ulcerations of cow-pox and those of horse-pox. 3. The dissimilarity of the eruption observed on the cows at Eysines and the cow at Laforêt. This dissimilarity is certified by Drs. Landeau and Pujos, who saw the two eruptions; whence this conclusion: Are there several eruptive diseases among bovines capable of yielding the true vaccine?

Compare Bousquet, *Nouveau Traité de la Vaccine:* Non seulement les symptômes généraux n'ont rien de fixe, mais les symptômes locaux eux-mêmes varient sans cesse, la maladie restant toujours la même, et premièrement la forme des pustules n'est pas toujours ronde il s'en faut; il y en a d'ovales, de longitudinales; les unes sont plates, déprimées; les autres globuleuses, conoïdes, etc. A l'egard de la couleur, il y en a de blanches, d'autres d'un blanc clair ou ardoisé, d'autres sont jaunatres, enivrées, etc. Tout dépend de la couleur même des trayons. L'aréole existe ou n'existe pas; alors même qu'elle existe, la nuance de l'epiderme ne permet pas toujours de la distinguer. En resumé il n'y a que variations dans les caractères tirés du développement de la forme, de la nature, et de la marche des pustules; aucun n'indique surement le vrai cow-pox, aucun ne l'exclut. Il n'y a (selon Verheyer) qu'un caractère infallible c'est la structure anatomique.

[7] This is a much better plan than the inoculation of children with lymph direct from the cow's teat or the milker's hand. For unless the practitioner

vesicle and be used directly on a child, and carried on from arm to arm, but retro-vaccination of calves, as will be seen by Ceely's and my own experiments, is both uncertain and unsatisfactory.

Diseases which may be mistaken for Cow-pox.—It must not be supposed that any sores or eruption on the teats of a cow necessarily indicate cow-pox. It is necessary to bear in mind the existence of the following diseases of the teats of cows:—

Chapped Teats.—Sores on the teats may result from slight injuries, such as scratches from brambles while the cows are out at pasture. Cowmen also describe a similar condition arising from the cows soiling their teats in muddy ponds and being afterwards exposed to dry winds. The same may occur as the result of inflammation of the udder soon after calving. This shows itself in the form of excoriations or sores, or small cracks or chaps on the teats, which are very troublesome (Youatt).

Blister Pock, the White Vesicle or White Pock.—Variolæ vaccinæ bullosæ (Gunzel), bullatæ (Osiander), albæ (Jenner), vesiculosæ, pemphigoides; Wasser oder Windpocken (Hering).—This disease is communicable from the cow to the milker if the hand is not quite sound, and is conveyed by the milker to other cows. Jenner gives a case of transmission to the milker: "On the fingers of each of the girl's hands there appeared several large white blisters. She supposes about three or four on each finger. The hands and arms inflamed and swelled, but no constitutional indisposition followed."

Hering points out that the structure of the vesicle is characteristic. There is only a simple raising of the epidermis, and in twenty-four hours the vesicle has reached the size of a pea or bean. The contents are sometimes absorbed and the vesicles are then found empty. Ceely also speaks of the vesicles as being subepidermic, and distinguished from the true cow-pox in that the cellular character is wanting. When communicated to man, according to the same authority, the vesicle may resemble in appearance the vaccine vesicle; "but, on examination with a lancet, it is found neither cellular nor possessed of the fluid contents. It is in a state of dessication, and has retained this appearance and its integrity so long, on account of the thickness of the epidermis."

Aptha Epizootica—Fièvre Aptheuse—"Foot-and-Mouth Disease" on the Teats.—This disease may be mistaken for cow-pox if a medical man on discovering vesicles on the cow's teats makes a diagnosis without entering any further into the clinical history. It is most important, therefore, to bear in mind that if milch cows are affected with vesicles on the teats a careful examination should be made for any eruption in the mouth or on the feet.

The best description of the eruption in milch cows is given by Rayer. The number of vesicles may vary from six to forty. They appear first about the size of a large pin, and enlarge till they form flattened circular vesicles. The vesicles dry up about the tenth or eleventh day, and a brownish thin crust forms and is detached about the sixteenth or eighteenth day of the malady. If subjected to the tractions of the milkers, there results a super-

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avoid the use of lymph which has not been attenuated sufficiently, he will very probably experience what Bousquet has described as "les frayeurs de Jenner." Compare also Seaton, *Handbook of Vaccination*:—"A lymph-stock which was set in circulation by Mr. Estlin of Bristol in 1838 produced in its earliest transmissions much of that extreme local irritative effect which Jenner and others describe as attending the use of unhumanised lymph, and which, so far from regarding as an advantage they were always anxious to control. It was so exceedingly irritative that I know that life was endangered in some instances by the use of it, and I rather thank a fatal case or two occurred."

ficial excoriation of a brownish red colour covered with a crust consisting largely of dried blood. But these ulcerations do not degenerate into phagedænic ulcers like those which often occur in cow-pox. The disease is communicable to man, especially when the milk is drunk while still warm from the cows. Vesicles make their appearance on the lips and tongue. M. Hertwig, who drank the milk as an experiment, also suffered from vesicles on the fingers. They ran a less rapid course than those on the mouth. They were filled with a liquid resembling turbid lymph, increased in size, and became confluent at several points; then ruptured, dried up, and the epidermis became detached from the afflicted parts.

Yellow-Pock is a disease described by Nissen as an eruption yellow from its first appearance, and continuing so. It is accompanied with an extremely unpleasant—almost putrid—smell, and soon degenerates into ulcerations, from which pus and blood exude. The disease is communicable from one cow to another, and to man;[8] boils and ulcers resulting.

Bluish or Black Pock, is described as forming bluish or black, or livid vesications on the teats and udders, followed by thin dirty brown or black irregular crusts and some degree of impetigo on the interstices near the bases of the teats (Ceely).

Warts.—These are of two kinds, "long narrow pendulous and linear-shaped prolongations, easily removed, and often detached, the other short, thick, compact, broad elevations, lighter in colour generally than the ground from which they rise, of various sizes, from that of a pea to that of a horse-bean, frequently very numerous on the teats, where they are found bleeding and partially detached" (Ceely).

"Other eruptions have been observed, but these, like chapped teats and warts, from their description could scarcely be mistaken for cow-pox." Such are "suppuration of the cutaneous follicles at the base of the teats; small hard knots, cutaneous or subcutaneous, in the same locality, about the size of a vetch, a pea, or even larger, which often remain indolent for a time, at length become red, vesicate, enlarge, suppurate, and burst after attaining not infrequently the size of a walnut or more, occasionally affecting the hands of the milker and often the other cows milked in the same shed by the same hands; an eczematous eruption, with intertrigo on the udder and near the roots of the teats" (Ceely). To this list may be added the condition of the teats which is met with in the cattle-plague.

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[8] Ceely met with a case which he describes as follows:—"Not long since I saw a wife and five children labouring under a pustular disease of six weeks' standing, and infected by the father, who had caught the disease from the cow, which was in a terrible condition. It was of the character of ecthyma, but communicable, affecting the face, trunk, and limbs, and could be propagated by inoculation."